Consortium for Educational Communication

Module
on
Food Additives

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M.Sc Food technology

TEXT

FOOD ADDITIVES

1. INTRODUCTION:

We all need food and most of us derive great pleasure from it. The modern day consumer demands ever increasing standards of quality, choice, convenience and, of course, safety.

Food additives are not a new invention. Since early times, there has been a need to preserve food from one harvest to another and to improve the presentation and nutritional value of food. The use of salt and smoke for preservation dates back to early history. The Egyptians used colours and flavourings, while the Romans used saltpetre, spices and colours.

Since the first half of this century, new substances have been discovered which fulfil these and other beneficial functions at relatively low cost. Examples of such early food additives are colours in cheese, emulsifiers in margarine, baking powder in cake mixes and gelling agent in jams. In the last 40 years, developments in food science and technology, as well as changes in consumer demand, have led to a substantial increase in the use of food additives. This has enabled the food industry to produce a wide range of foodstuffs of good and uniform quality at reasonable prices.

Additives need to be used only in small quantities to be effective, typically less than 1% in the final food. Many additives, e.g. antioxidants, preservatives and flavourings, are effective at levels below 0.1 %. The use of additives is regulated by FSSAI in India.

1.1. DEFINITION:

Food additives are substances which are added to food which either improve the flavor, texture, colour, taste, appearance or function as processing aid. Food additives arenon nutritive substances added intentionally to food, generally in small quantities, to improve its appearance, flavor, texture or storage properties. A broad definition of "food additive" is any substance the intended use of which results, directly or indirectly, in it's becoming a component of or otherwise affecting the characteristic of any food, and which is safe under the condition of its use.

2. NEED FOR FOOD ADDITIVES:

1. Additives provide protection against food spoilage during storage, transportation, distribution or processing. Also, with the present degree of urbanization, it would be impossible to maintain food distribution without processing.

2. A number of factors have lead to the demand for foods with builtin preparation of "convenience" foods. The "convenience food revolution" would not have been possible without food additives.

3. Many of these chemical additives can be manufactured so that foods can be "fortified" or "enriched". Potassium iodide, for instance, added to common salt can eliminate goiter, enriched rice or bread with B-complex vitamins can eliminate pellagra, and adding vitamin D to cow milk prevents rickets.

4. Many foods, particularly those with high moisture contents, do not keep well. All foods are subjected to microbial attack. Fats or oily foods become rancid, particularly when exposed to humid air. Protection of quality of foods against agents causing such deterioration requires the addition of preservatives. Additives are also used to colour foods, add flavor, impart firmness, and retard or hasten chemical reaction in food.

5. The use of food additives is to maintain the nutritional quality of food, to enhance stability with resulting reduction in waste, to make food more attractive, and to provide efficient aids in processing, packaging and transport.

3. TYPES OF ADDITIVES:

3.1. Acidulants:

Acidulants are food additives used to impart a sharp, characteristic taste to foods. They also assist in the setting of gels and to act as preservatives. In biological systems, it is extremely important to maintain a constant pH. The delicate balance of processes within the living cell can easily be upset by fluctuations in acidity or alkalinity. Living systems contain within them solutions called buffers which are capable of 'mopping up' any chemicals which may significantly alter the pH. In this way buffers are acting as pH regulators. Many natural foods are acidic, for example, oranges, lemons, apples, tomatoes, cheese and yoghurt. The natural acids present in these foods give them their characteristic taste. Baking soda (sodium hydrogencarbonate) is an example of an alkali. Food acids, with the exception of phosphoric acid, are all organic acids and are present within the living cells of plants and animals. As the food industry has developed, so has the growth in production of processed foods. Many of these need the inclusion of an acidulant to impart an acidic or sour taste.

Acids and applications

Gluconolactone also can be used for slow acid production in cultured dairy products and chemical leavening systems because it slowly hydrolyzes in aqueous systems to form gluconic acid (Fig. 1). Dehydration of lactic acid yields lactide, a cylicdilactone (Fig. 2), which also can be used as a slow-release acid in aqueous systems. The dehydration reaction occurs under conditions of low water activity and elevated temperature. Introduction of lactide into foods with high water activity causes a reversal of the process with the production of two moles of lactic acid.

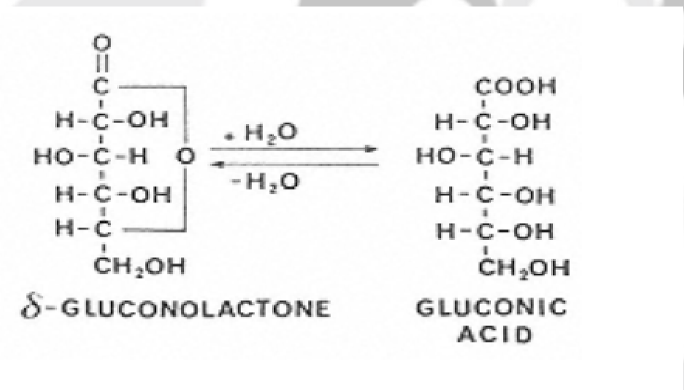

Fig. 1.Formation of gluconicacid from the hydrolysis of d-gluconolactone.

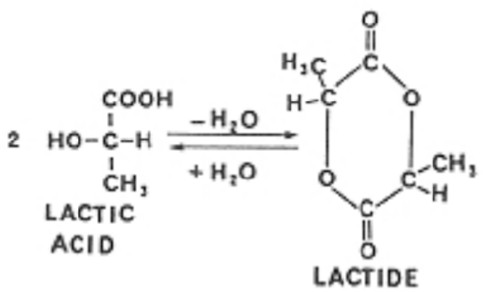

Fig. 2. Equilibrium reaction showing formation of lactic acid from the hydrolysis of lactide

Acids such as citric are added to some moderately acid fruits and vegetables to lower the pH to a value below 4.5. In canned foods this permits sterilization to be achieved under less severe thermal conditions than is necessary for less acid products and has the added advantage of precluding the growth of hazardous microorganisms (i.e., *Clostridium botulinum).*

Acids, such as potassium acid tartrate, are employed in the manufacture of fondant and fudge to induce limited hydrolysis (inversion) of sucrose. Inversion of sucrose yields fructose and glucose, which improve texture through inhibition of excessive growth of sucrose crystals. Monosaccharides inhibit crystallization by contributing to the complexity of the syrup and by lowering its equilibrium relative humidity.

Numerous organic acids are available for food applications. Some of the more commonly used acids are acetic (CH3COOH), lactic (CH3-CHOH-COOH), citric [HOOC-CH2-COH(COOH)-CH2-COOH], malic (HOOC-CHOH-CH2- COOH), fumaric (HOOC-CH=CH-COOH), succinic (HOOC-CH2-CH2-COOH), and tartaric (HOOC-CHOH-CHOHCOOH).

Phosphoric acid (H3PO4) is the only inorganic acid extensively employed as a food acidulant. Phosphoric acid is an important acidulant in flavored carbonated beverages, particularly in colas and root beer. The other mineral acids (e.g., HCl, H2SO4) are usually too highly dissociated for food applications, and their use may lead to problems with quality attributes of foods.

3.2. Preservative:

Food preservatives have to be safe for human consumption. They must not impair the function of the cells of the human body, whilst they are interfering with the normal functioning of microbial cells responsible for decay. All preservatives have particular optimal impact at specific concentrations. Use of too lowconcentration may result in inadequate control of microorganisms. This may extend the shelf life of a product for a limited period only. Preservatives tend to be used at a concentration sufficiently high to suppress microbial growth.

There is much concern about the increasing incidence of the phenomenon of resistance of bacteria to antibiotics. Over the decades in which preservatives have been used, there has been no need to increase the dosage to maintain their effectiveness. It has been summarised that the use of these substances has not resulted in the selection of bacterial strains which are resistant to preservatives.

The range of preservatives

There are over 80 substances which have permitted for use as preservatives.

Sorbic acid (C-C=C-C=C-COOH) and its sodium and potassium salts are widely used to inhibit mold and yeasts in a wide variety of foods including cheese, baked products, fruit juices, wine, and pickles. Sorbic acid is particularly effective in preventing mold growth, and it contributes little flavor at the concentrations employed (up to 0.3% by weight). The method of application may involve direct incorporation, surface coatings, or incorporation in a wrapping material. The activity of sorbic acid increases as the pH decreases, indicating that the undissociated form is more inhibitory than the dissociated form. In general, sorbic acid is effective up to pH 6.5, which is considerably above the effective pH ranges for propionic and benzoic acids.

Benzoic acid and its salts is also a widely used preservative and its use is important in less well developed countries. It is only used in acidic situations which include non-alcoholic beverages, products prone to spoilage by bacteria and fruit-based products.

Sulphur dioxide (SO2) and its derivatives have been used in foods as general food preservatives. They are added to food to inhibit nonenzymic browning, to inhibit enzyme catalyzed reactions, to inhibit and control microorganisms, and to act as an antioxidant and a reducing agent. The commonly used forms in foods include sulphur dioxide gas and the sodium, potassium, or calcium salts of sulfite, bisulfite, or metabisulfite. The most frequently used sulfiting agents are the sodium and potassium metabisulfites because they exhibit good stability toward autoxidation in the solid phase.

The potassium and sodium salts of nitrite and nitrate are commonly used in curing mixtures for meats to develop and fix the color, to inhibit microorganisms, and to develop characteristic flavors. Nitrite rather than nitrate is apparently the functional constituent. Nitrites in meat form nitric oxide, which reacts with heme compounds to form nitrosomyoglobin, the pigment responsible for the pink color of cured meats. Nitrites have been shown to be involved in the formation of low, but possibly toxic, levels of nitrosamines in certain cured meats. Nitrate salts also occur naturally in many foods, including vegetables such as spinach.

Propionic acid (CH3-CH2-COOH) and its sodium and calcium salts exert antimicrobial activity against molds and a few bacteria. This compound occur naturally in Swiss cheese (up to 1% by weight), where it is produced by *Propionibacteriumshermanii* .Propionic acid has foundextensive use in the bakery field where it not only inhibits molds effectively, but also is active against the ropy bread organism, *Bacillus mesentericus.* Levels of use generally range up to 0.3% by weight.

Nisin is a naturally occurring antibacterial substance used in some dairy products and another, natamycinis used on the rind of ripened cheeses or dried meats.

3.3. Nutritional Additives:

Nutritional additives have increased in use in recent years as consumers have become more concerned about and interested in nutrition. The nutritional additives are not included as a functional class within the INS or E numbering system, although several of the additives are included under other functional classes and as expected serve several functions in these products. Vitamins, which as indicated above are also used in some cases as preservatives, are commonly added to cereals and cereal products to restore nutrients lost in processing or to enhance the overall nutritive value of the food. The addition of vitamin D to milk and of B vitamins to bread has been associated with the prevention of major nutritional deficiencies. Minerals such as iron and iodine have also been of extreme value in preventing nutritional deficiencies. Like vitamins, the primary use of minerals is in cereal products. Amino acids and other proteinaceous materials are not commonly used in foods. However, lysine is sometimes added to cereals to enhance protein quality. Proteins or proteinaceous materials such as soy protein are also sometimes used as nutritional additives, although they are most commonly used as texturizing agents. Fiber additives have seen increased popularity in recent years with the increase in consumer interest in dietary fiber. Various cellulose, pectin, and starch derivatives have been used for this purpose. Recently, naturally derived fiber from apples and other fruits as well as sugarbeets has been introduced as a fiber additive. Fiber additives are not well defined and in reality have little or no direct nutritional value, although they do have indirect nutritional benefits. In some cases, fiber additives also provide improved texture to food products and are categorized as bulking agents, thickeners, or stabilizers. The number of food additives used for special dietary purposes has increased significantly in recent years with an emphasis on the replacement of fat to reduce calories.

3.4. Colouring Agent:

These include colour stabilizers, colour fixatives, colour retention agents, etc. They consist of synthetic colours, synthesized colours that also occur naturally, and other colours from natural sources. Even though colours add nothing to the nutritive value of foods, without certain colours most consumers will not buy or eat some foods. Thus, colours are frequently added to restore the natural ones lost in food processing or to give the preparations the natural colour we expect. A number of natural food colours extracted from seeds, flowers, insects, and foods, are also used as food additives. One of the best known and most widespread red pigment is bixin, present in Annatto derived from the seed coat of *Bixaorellana,* the lipstick pod plant of South American origin. Bixin is not considered to be carcinogenic.Annatto has been used as colouring matter in butter, cheese, margarine, and other foods. Another yellow colour, a carotene derived from carrot, is used in margarine. Saffron has both flavouring and colouring properties and has been used for colouring foods. Turmeric is a spice that gives the characteristic colour of curries and some meat products and salad dressings. A natural red colour carmine is obtained from cochineal insect (Dactylopiuscoccus), and caramel, the brown colour obtained from burnt sugar, are some natural colours that are used as food additives.

3.5. Flavoring Agents:

Flavoring agents comprise the greatest number of additives used in foods. There are three major types of flavoring additives: sweeteners, natural and synthetic flavors, and flavor enhancers.

3.5.1. Sweetners

The most commonly used sweeteners are sucrose, glucose, fructose, and lactose, with sucrose being the most popular. These substances, however, are commonly classified as foods rather than as additives. In many ways, sucrose is an ideal sweetener; it is colourless, soluble in water, and has a "pure" taste, not mixed with overtones of bitterness or saltiness. But it is rich in calories. Diabetics and overweight, whorestrict their intake of sugar, must have an alternative to sucrose. Thus, synthetic non-nutritive sweeteners, having less than two per cent of the calorific value of sucrose, for equivalent unit of sweetening capacity came into use. The first synthetic sweetening agent used was saccharin, which is about 300 times sweeter than sucrose in concentrations up to the equivalent of a 10 per cent sucrose solution. Acesulfame K is used in baked goods, chewing gum, gelatin desserts, and soft drinks. It is about 200 times sweeter than sugar. Aspartame is used in "Diet" foods, including soft drinks; drink mixes, gelatin desserts, and low calorie frozen desserts. Aspartame is produced from two amino acids—aspartic acid and phenylalanine—and is 180 times sweeter than sucrose.

3.5.2. Natural and synthetic flavours:

In addition to sweeteners, there are more than 1700 natural and synthetic substances used to flavor foods. Natural flavor are substances, such as spices, herbs, roots, essences, and essential oils, have been used in the past as flavor additives. The flavours are in short supply and the amount of flavor substances in them is very tiny. It would take about tonne of many spices to produce 1 g of the flavor substances, and in some cases only 0.1 g can be extracted. Natural food flavours are thus being replaced by synthetic flavor materials.

The agents responsible for flavor are esters, aldehydes, ketones, alcohols, and ethers. These substances are easily synthesized and can be easily substituted for natural ones. Typical of the synthetic flavor additives are amyl acetate for banana, methyl anthranilate for grapes, ethyl butyrate for pineapple, etc. Generally, most synthetic flavours are mixtures of a number of different substances. For example, one imitation cherry flavor contains fifteen different esters, alcohols, and aldehydes.

3.5.3 Flavour enhancers:

Flavor enhancers magnify or modify the flavor of foods and do not contribute any flavor of their own. One of the best known, most widely used and somewhat controversial flavor enhancers is monosodium glutamate (MSG), the sodium salt of the naturally occurring amino acid glutamic acid. This is added to over 10,000 different processed foods. About 65 years ago, a Japanese named Ikeda discovered that the flavouring from these is MSG and that it has an attractive meat-like flavor. MSG is now manufactured on a large scale all over the world, and especially in Japan. MSG is generally recognized as safe. However, it was reported some time back that MSG injected to young mice resulted in brain damage. Also, some individuals experience symptoms often comparable to those of heart attack, when served with food containing large amounts of MSG. The matter has now been thoroughly investigated, and it has been concluded that there is no risk in its use. However, MSG which was being added to baby foods is now discontinued, as its benefits to babies are dubious.

Yeast extract has the same flavor enhancing property as MSG. It is found that, in this case, the flavor enhancing substances are the ribonucleotides. These are ten times more powerful than MSG.

3.6. Emulsifiers

Emulsions found in the context of food can be of two sorts, oil-in-water emulsion (o/w) and water-in-oil emulsion (w/o). An emulsifier or emulsifying agent has the ability to keep an emulsion mixture in a stable state, that is, the two immiscible liquids are prevented from separating.

The most important functional types are:-

Emulsion stabilisation

Food emulsions are either oil-in-water emulsions, e.g. liquid milk, or water-in-oil emulsions, e.g. margarine,. The emulsifiers allow the oil and water to be mixed more easily resulting in a finer droplet size of whichever phase is dispersed within the continuous phase.

Dough-conditioning

Wheat is by far the most important cereal crop. Wheat flour is used in the production of bread. During the processing of wheat dough, a wheat protein called gluten forms a network which is responsible for the dough’s elastic nature. A high quality product will only be produced if this network is of a good quality. If it is weakened during processing, the carbon dioxide produced during yeast fermentation will escape resulting in bread of poor quality. Emulsifiers with larger molecular structures, particularly diacetyl tartaric esters of monoglycerides (E472e), interact with the gluten in such a way as to strengthen the gluten network.

Starch complexing

Starch, which is present in flour, consists of two types of carbohydrate. These are called amylose and amylopectin. Amylose is a smaller molecule than amylopectin. When flour is mixed with water, both carbohydrates swell and form a gel. However, with time, the starch components will re-crystallise and squeeze the water out of the gel. This phenomenon is known as retrogradation. This is responsible for, amongst other things, the staling process in bread. Amylose retrogradation occurs more rapidly than amylopectin retrogradation. Some emulsifiers, e.g. monoglycerides (E471), can form complexes specifically with amylose and hence retard the rate of retrogradation. They are used as antistaling agents in bread.

Aeration and foam stablization

Foam consists of a gas dispersed in a continuous liquid phase. A great number of food emulsions (o/w) are aerated to produce foams, e.g. dairy and non-dairy cream, ice-cream, re-hydrated spray toppings. When milk is used in these products, the presence of milk proteins act as natural emulsifiers. Thus if other emulsifiers are added it is for a different function. They are used to influence whipping and improve properties such as stiffness, volume and stability of the finished foam. During the whipping/aeration process they promote the agglomeration (clustering together) of the fat globules. The fat globules are then capable of coating the small pockets of air which are introduced during whipping. Therefore, the foam produced is stabilised.

How do emulsifiers work?

Essentially emulsifiers can be thought of as consisting of two parts. One of these parts is described as being hydrophilic. The other part is a lipophilic structure.

In a w/o emulsion, the emulsifier is orientated in such a way so that the polar part dissolves in the water and the lipophilic part dissolves in the oil (fig 3). In effect, the emulsifier forms a complete protective film around the water droplets and yet allows them to be dispersed evenly through the oil.

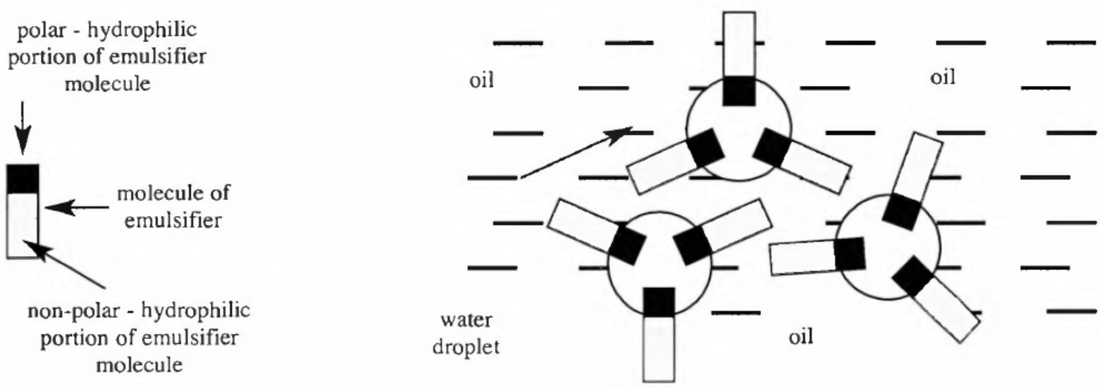

Fig.3

This property makes emulsifiers indispensable in the modem food industry where foams, suspensions (particles of solid dispersed evenly through a liquid) and emulsions are used so frequently.

3.7. Stablizers

Many natural raw materials are used in the stabiliser industry. The stabilising properties of many natural raw materials have been used in foods for hundreds of years. The ingredients used in the stabiliser industry are varied and widespread.

Applications

Some examples of common applications include:

for gelling agents

- Jams and marmalade, which often use pectin.
- Fruit preparations used in dairy desserts and in bakery products such as pies, tarts and biscuits.
- Desserts and confectionery jellies - to enable them to set.
- Vegetarian burgers, sausages, etc. - to hold them together as they cook.

for stabilisers

- Ice cream and ice lollies - to prevent the appearance of large, grainy ice crystals or ice lumps and give ice cream the firm texture, smooth taste and good keeping qualities associated with the modem product.
- Many reduced fat or low fat products - in their manufacture.

Sauces and dressings

- to avoid the separation of the oil and aqueous components.

for thickeners

- Many sugar reduced or low sugar products require gelling agents or thickeners to substitute the performance effects of sugar in the traditional product.

How do they work?

Stabilisers improve the stability of a mixture, such as an emulsion, by increasing the viscosity. Stabilisers increase the interlocking and interactions between the long chains of molecules present in an emulsion. This reduces the freedom of movement of the dispersed droplets and lessens the chance of their coming into contact and coalescing. If the molecular interactions are particularly strong - and often this is helped by additional components in the foodstuff - gelation may occur. In gelation, commonly the polymers will form a regular ordered structure, similar to crystallisation. This is the case in jams, table jellies, etc

3.8.Anti caking agents

Several conditioning agents are used to maintain free-flowing characteristics of granular and powdered forms of foods that are hygroscopic in nature. In general, these materials function by readily absorbing excess moisture, by coating particles to impart a degree of water repellency, and/or by providing an insoluble particulate diluent. Calcium silicate ($Ca SiO3 \cdot XH2O$) is used to prevent caking in baking powder (up to 5%), in table salts (up to 2%), and in other foods and food ingredients. Finely divided calcium silicate absorbs liquids in amounts up to 2½ times its weight and still remains free flowing. In addition to absorbing water, calcium silicate also effectively absorbs oils and other nonpolar organic compounds. This characteristic makes it useful in complex powdered mixes and in certain spices that contain free essential oils.

Flow problems in powders can be caused by several factors which can occur singly or in combinations. Moisture is a prime cause of caking and it can affect flow through several mechanisms: Water contained in powder particles often tends to migrate to the surface. This makes the particles damp. Insoluble products tend to draw water towards them, also causing dampness. Hygroscopic powders absorb moisture in the air. In extreme cases this can lead to the breaking up of the material and cause ‘tackiness’. Variations in relative humidity can lead to caking. Particle size and shape can affect the way in which a powder settles. Particular size/shape combinations can severely affect flow properties.

3.9. Antioxidants

Oxidation occurs when electrons are removed from an atom or group of atoms. Simultaneously, there is a corresponding reduction reaction that involves the addition of electrons to a different atom or group of atoms. Oxidation reactions may or may not involve the addition of oxygen atoms or the removal of hydrogen atoms from the substance being oxidized. Oxidationreduction reactions are common in biological systems, and also are common in foods. Although some oxidation reactions are beneficial in foods, others can lead to detrimental effects including degradation of vitamins, pigments, and lipids with loss of nutritional value and development of off flavors. Control of undesirable oxidation reactions in foods is usually achieved by employing processing and packaging techniques that exclude oxygen or involve the addition of appropriate chemical agents. Before the development of specific chemical technology for the control of free-radical-mediated lipid oxidation, the term antioxidant was applied to all substances that inhibited oxidation reactions regardless of the mechanism. For example, ascorbic acid was considered an antioxidant and was employed to prevent enzymic browning of the cut surfaces of fruits and vegetables. In this application ascorbic acid functions as a reducing agent by transferring hydrogen atoms back to quinones that are formed by enzymic oxidation of phenolic compounds. In closed systems ascorbic acid reacts readily with oxygen and thereby serves as an oxygen scavenger. Likewise, sulfites are readily oxidized in food systems to sulfonates and sulfate, and thereby function as effective antioxidants in foods such as dried fruits. The most commonly employed food antioxidants are phenolic substances. More recently the term “food antioxidants” often has been applied to those compounds that interrupt the free-radical chain reaction involved in lipid oxidation and those that scavenge singlet oxygen; however, the term should not be used in such a narrow sense. Many naturally occurring substances possess antioxidant capabilities, and the tocopherols, ascorbic acid and vitamin E are noted examples that are widely employed. Recently, extractives of spices, particularly rosemary, also have been successfully commercially exploited as natural antioxidants. Gossypol, which occurs naturally in cottonseed, is an antioxidant, but it has toxic properties. Other naturally occurring antioxidants are butylatedhydroxyanisole (BHA), butylatedhydroxytoluene (BHT), propyl gallate, and dit-butylhydroquinone (TBHQ), which are synthetic phenolic antioxidants currently approved for use in foods. Nordihydroguaiaretic acid, a compound related to some of the constituents of gum guaiac, is an effective antioxidant, but its use directly in foods has been suspended because of toxic effects. However, b-carotene is considered to function more efficiently as a singlet oxygen scavenger than phenolic substances.

Thiodipropionic acid and dilaurylthiodiproprionate remain as approved food antioxidants, even though removal of these compounds from the approved list was recently proposed because they were not being used in foods. Although thiodipropionates, at levels allowed in foods, are ineffective in reducing peroxide values, they are highly effective in decomposing peracids (Fig. 4) found in oxidizing lipids. Peracids are very efficient substances for mediating the oxidation of double bonds to epoxides, and in the presence of water, epoxides formed by this reaction readily hydrolyze to form diols.Because the thiodipropionates readily inhibit the accumulation of peracids, they have been retained as approved antioxidants.

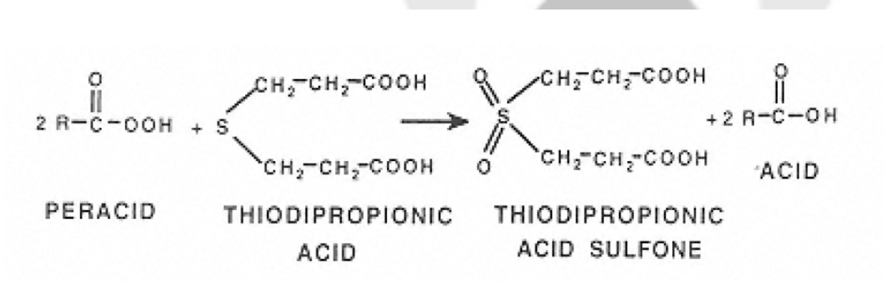

Fig. 4.Mechanism of hydroperoxide decomposition by thiodipropionic acid

3.10. Other additives

There are numerous other chemicals used in food products for specific yet limited purposes. Included are various processing aids such as chelating agents, clarifying agents,firming agents, freezing agents and various solvents, gases and propellents.

3.10.1. Chelating agents

Chelating agents are not anti-oxidants. They serve as scavengers of metals which catalyze oxidation. EDTA is a chelating agent permitted for use in the food industry as a chemical preservative. Calcium disodium EDTA and disodium EDTA have been approved for use as food additives by the United States Food and Drug Administration.

3.10.2.Clarifying agents

Clarifying agents like bentonite, gelatins, synthetic resins (polyamides and poly vinyl pyrrolidone) are used to remove haziness or sediments and oxidative deterioration products in fruit juices, beers and wines. Enzymes are added to bring about desirable changes; rennin for producing curd and cheese, papain for tenderizing meat, and pectinase for clarifying beverages.

3.10.3. Firming agents

Firming agents are used in food and beverage applications to give a product consistency in texture, shelf life and strength by improved binding ability. Firming agents are used in various types of processed foods. Some of these food products are processed or canned vegetables and fruits. Calcium chloride is also used in certain types of cheese. Firming agents such aluminium sulphates and calcium salts are used to keep the tissues of fruits and vegetables crisp.

3.10.4Freezing agents

Freezing agents like liquid nitrogen and dichlorofluoro methane, which are extremely volatile and rapidly evaporate at ordinary temperatures, are used to chill foods.

3.6.5. Gases and Propellants

Gases, both reactive and inert, play important roles in the food industry. For example, hydrogen is used to hydrogenate unsaturated fats, chlorine is used to bleach flour and sanitize equipment, sulfur dioxide is used to inhibit enzymic browning in dried fruits, ethylene gas is used to promote ripening of fruits, ethylene oxide is used as a sterilant for spices and air is used to oxidize ripe olives for color development. Packing gases, such as inert gases, are added to packets of instant foods to prevent oxidative and many other changes.

4. Safety of a Food Additive:

The limit should be established with due importance to following factors:

a. The estimated level of consumption of the food product by the consume world for which the additive is proposed.

b. Finding out minimum levels which would produce significant deviation from physiological behavior.

c. An adequate margin of safety to reduce any hazard to a minimum.

d. Legal control over the use of food additives.This can be accomplished only when a list of permitted additives exists with specified safe levels and toxic levels.

e. Stringent labeling on foods i.e., declaring the usage of additives in food and their quantities.

f. Employing trained food inspectors, food control laboratories and reliable analytical methods are of utmost important for regulation / control over usage of food additives.